Changes in accessibility to foodbanks during COVID-19 and implications for the food security of vulnerable populations in Hamilton, Ontario

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Abstract

This is the abstract.

It consists of two paragraphs.

CRediT author statement

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Introduction

Food insecurity, defined as an "inadequate or uncertain access to a sufficient quantity and/or adequate quality of food" due to a household's financial limitations (Enns et al., 2020), has been associated with reductions in nutritional outcomes (Bhattacharya et al., 2004; Kirkpatrick and Tarasuk, 2008; Olson, 1999) and physical and mental health in children and adults (Elgar et al., 2021; Jones, 2017; Ramsey et al., 2011; Seligman et al., 2010; Stuff et al., 2004). Over at least the past four decades food banks have become an essential line of defense against food insecurity in Canadian communities (Black and Seto, 2020; Holmes et al., 2018; Riches, 2002; Tarasuk et al., 2020). In this respect, Canada is not unlike numerous other wealthy countries where a systematic dismantling of the welfare state took place in the intervening period (Tarasuk et al., 2014).

But the emergence of COVID-19, the worst public health crisis since the 1918 flu pandemic, has revealed important social and economic fault lines, and pre-existing patterns of inequality appear to have been exacerbated. Along several other dimensions of stress [e.g., accessibility to health care facilities; Pereira et al. (2021a)], this seems to be the case for food insecurity as well (Laborde et al., 2020). In the US, for example, it has been estimated that there was an increase of more than 30% in household food insecurity, and more than one third of households were discovered to be newly food insecure - meaning they did not experience food insecurity before the pandemic (Niles et al., 2020). In Canada, Men and Tarasuk (2021) report that about 25% of individuals who experienced job insecurity (a relatively common occurrence during the pandemic), also experienced food insecurity. Similarly, according to Statistics Canada (2020a), in the early stages of the pandemic almost 15% of individuals reported living in a household that faced food insecurity; the risk of food insecurity was substantially higher for households with children. The difference between households with and without children was significant, and 11.7% of households with children indicated that "food didn't last and [there was] no money to get more" sometimes or often, compared to 7.3% of households without children); likewise, 13% of households with children indicated that they "[c]ouldn't afford balanced meals" sometimes or often, compared to 8.8% of households without children.

The impacts of food insecurity during the pandemic are alarming, since diet-related diseases, such as obesity, heart-disease, and diabetes, were already critical public health concerns in Canada prior to COVID-19 (Boucher et al., 2017). While food banks are not necessarily a stable solution to food insecurity and in fact may encourage a retrenchment of neoliberal policy (Wakefield et al., 2013), at least they can be argued to provide a resource of last instance to households in precarious situations (Bazerghi et al., 2016). As recently as 2019, the Hamilton Hunger Report[1] noted that food banks in Hamilton, Ontario, recorded the highest number of visitors in the past 29 years; the number of

[1] https://www.hamiltonfoodshare.org/wp-content/uploads/Hamilton-Food-Share-Hunger-Report-2019.pdf

children visiting food banks (minors up to 18 years old) was 9,125 in March 2019, up from 8,278 the year before.

It is known that the urban food environment, within which people make their daily food choices, is essential in influencing eating behaviours and health outcomes, based on factors such as food availability, ease of geographic accessibility and socio-demographic variations (Paez et al., 2010; Vanderlee and L'Abbé, 2017; Widener, 2018). However, while there is a wealth of literature that has examined the topic of geographic accessibility to healthy food through the "food desert" concept, there has been little research into accessibility to food banks. Although previous work has explored differences in *accessing* food banks, such as how some households utilize food banks over short periods of time while others regularly utilize food banks as longer-term resource (e.g., Enns et al., 2020), we are not aware of any research that has focused on the geographic component of accessibility. **Check Tarasuk et al. (2019)**

The study of place-based geographic accessibility is concerned with capturing the potential to reach destinations of value using the transportation network (Páez et al., 2012). Indeed, the Government of Canada's recent Food Policy has made "access" to healthy food a priority for Canadian communities[2] and previous survey research has suggested that such accessibility plays a key role in user satisfaction with food bank service delivery in Vancouver (Holmes et al., 2018). However, as with research into the prevalence of food deserts, accessibility to food banks is likely not evenly distributed throughout a city with variations in access attributable to transportation network characteristics and the spatial distribution of food bank locations - as well as the population that likely needs them. Furthermore, policy responses to the COVID-19 pandemic add to the distress of vulnerable households. Non-pharmaceutical interventions during the pandemic involving restrictions in mobility increased the friction of travel, in particular by transit on which low income populations are more likely to be reliant (e.g., DeWeese et al., 2020). At the same time, the pandemic has created additional stress for the operators of foodbanks through disruptions in the supply chain (e.g., McKay et al., 2021) as well as concerns surrounding the delivery of service in safe conditions and possible cancellation of food service programs.

For this study, we aim to look at how the landscape of food banks and related services (e.g. low-cost or free meal service providers) available in Hamilton, Ontario, has changed before and during the pandemic. Have the number of open food bank services diminished? If so, what was the accessibility to foodbanks before and during the pandemic, from the perspective of low income households? And finally, who are most likely to have been impacted by changes to the accessibility landscape? This paper will first look at the distribution of food banks and related services before and during the pandemic. Then, we use the balanced floating catchment area approach of Paez et al. (Paez et al.,

[2]https://www.agr.gc.ca/eng/about-our-department/key-departmental-initiatives/food-policy/the-food-policy-for-canada/?id=1597863791042

2019) to investigate the accessibility situation. We use a fully disaggregated approach based on parcel-level data. Socio-economic and demographic data are drawn from the latest Census of Canada (2016), whereas travel information is from the most recent regional travel survey from 2016. This paper follows reproducible research recommendations (see Brunsdon and Comber, 2020), and the research was conducted using open source tools for transportation analysis (Lovelace, 2021). The code and data necessary to reproduce the analysis are available in a public repository[3].

Literature Review

Food Insecurity

Food insecurity is the inability to acquire and consume an adequate amount or good quality food, leading to inadequate nutrient intake (Kirkpatrick and Tarasuk, 2008; Tarasuk and Vogt, 2009). This nutrient deficiency has been causing major health concerns in Canadians, and particularly those who are at a socioeconomic disadvantage (Bazerghi et al., 2016). Previous studies have aimed to look at the relationship between the built food environment and socio-demographic characteristics with qualitative and quantitative, or a mixed -method approach. Quantitatively, official governmental surveys have been able to assist with data, such as the Household Food Security Survey Module (HFSSM), the Canadian Community Health Surveys (CCHS), the Longitudinal and International Study of Adults (LISA), and official classifications determined by Health Canada in relation to sociodemographic variables (Gundersen et al., 2018; Kirkpatrick and Tarasuk, 2008; Tarasuk and Vogt, 2009). Studies have also aimed to assess food availability of healthy foods (e.g., fruit and vegetables) at supermarkets in relation to sociodemographic characteristics and geographic accessibility (Latham and Moffat, 2007). In terms of findings, studies have generated inconsistent relationships between their evaluated availability of food and sociodemographic characteristics that go in hand.

Foodbanks

Food banks - sometimes also referred to as ‘food pantries’ and ‘food shelves’ - originated as a community response to aid those with inadequate food by voluntarily offering them meals and ingredients (Loopstra and Tarasuk, 2012; Riches, 2002). The scope and objectives of foodbanks can vary by region and by country, and these organizations can include not only prepared meals and aliments, but also shared spaces to connect in community gardens and community kitchens (Wakefield et al., 2013). Although in their origin foodbanks were meant to be provide a temporary solution to accommodate those in hunger due to job retrenchments and economic downfalls since the 1980s, over time they evolved into a community practice to secure emergency food supplies for those

[3]add repository

in need (Loopstra and Tarasuk, 2012; Wakefield et al., 2013). In Canada, the number of foodbanks has steadily increased in the past few decades (Wakefield et al., 2013). Previous studies have questioned whether food banks are able to offer a rounded nutritious supply of food, and if food banks are a sustainable on-going practice for those in need (Bazerghi et al., 2016; Riches, 2002). An inescapable reality, at the moment, is that despite their imperfections they provide urgently needed support for members of the population for whom foodbanks are frequently their primary location to get food (Bazerghi et al., 2016). **However, surveys revealed that only 20 to 30 percent of those experiencing food insecurity were found to frequent food banks in Canada (Tarasuk et al., 2014). Something about geographical access**

Food Insecurity in Canada during the COVID-19

Currently with the COVID-19 pandemic, disrupted economies, rising unemployment rates, and changes in poverty levels have disrupted the food environment and led to higher rates of food insecurity (Niles et al., 2020). In 2012, 12.4% of Canadians households and 11.8% Ontarian households experienced some degree of food insecurity (Gundersen et al., 2018; Tarasuk et al., 2020). Pandemic-related food security studies in the US have found a substantial increase in households experiencing food insecurity for the first time, and also in households experiencing more severe food insecurity than before (Niles et al., 2020; Wolfson and Leung, 2020). Most recently in May 2020, Canada recorded 14.7% of its population living in food insecurity in the past 30 days (Statistics Canada, 2020a). Food insecurity is a highly concerning public health issue due to its health impacts. Recent research suggests that food insecurity in adults can lead to experiencing more stressful events (El-hajj and Benhin 2021). Increases in food insecurity rates due to the pandemic, signal a change in the food environment with potential damages to population health during the course of the pandemic and beyond (Niles et al., 2020).

Methods and Materials

Methods

For the research in this paper we adopt the balanced floating catchment area approach of Paez et al. (2019). This method for estimating accessibility is a form of the common two-stage floating catchment area method (Luo and Wang, 2003; Radke and Mu, 2000). Floating catchment areas are used to estimate accessibility when there are potential congestion effects, and operate by calculating first the *demand* for spatially distributed services. The demand (usually the number of people who require a service) is used to calculate a level of service. In a second step, the level of service is allocated back to the population. Demand and level of service are allocated using some form of distance-decay to embody the geographical principle that, given a choice, people prefer to travel less than more when reaching destinations.

More formally, the first step of this method is as follows:

$$L_j = \frac{S_j}{\sum_{i=1}^{n} P_i w_{ij}}$$

where S_j is the level of supply at location j, in simplest terms whether a service point is present (i.e., $S_j = 1$) or not (i.e., $S_j = 0$); P_i is the population at location i that demands the service; and w_{ij} is a weight, typically a function of the distance between locations i and j. L_j is the level of service at location j and it is the inverse of the number of people that need to be serviced.

The second step in this process is then summing the level of service that each population unit can reach, according to the distance-decay weight:

$$A_i = \sum_{j=1}^{J} L_j w_{ji}$$

where A_i is the accessibility to the service, which is in the same units as the level of service: as the inverse of the population being serviced. When the population being serviced is low accessibility is high (i.e., there is little competition for the service), and viceversa.

Floating catchment area methods are prone to overestimation of the population and the level of service due to multiple-counting. The population at P_i is allocated to *every* service point j for which $w_{ij} > 0$. Similarly, the level of service at LOS_j is allocated to *every* population point for which $w_{ji} > 0$. This inflation effect has been known for several years, and several modifications have been proposed to mitigate it (Delamater, 2013; e.g., Wan et al., 2012). A definitive solution to this issue was presented by Paez et al. (2019). In order to avoid the multiple-counting in the summations, the population and the level of service need to be allocated *proportionally*. This is achieved by standardizing the weights as follows:

$$w_{ij}^{\text{st}} = \frac{w_{ij}}{\sum_{i=1}^{n} w_{ij}}$$

and:

$$w_{ji}^{\text{st}} = \frac{w_{ji}}{\sum_{j=1}^{J} w_{ji}}$$

The standardized weights satisfy the following conditions:

$$\sum_{i=1}^{n} w_{ij}^{\text{st}} = 1$$

and:

$$\sum_{j=1}^{J} w_{ji}^{\text{st}} = 1$$

As a result, the total population (and consequently, the level of service) are preserved system-wide:

$$\sum_{i=1}^{n} P_i w_{ij}^{\text{st}} = P_i$$

and also:

$$\sum_{j=1}^{J} L_j w_{ji}^{\mathrm{st}} = L_j$$

Data

Data have been prepared for sharing as a data package[4].

Statistics Canada

Population and income statistics at the level of Dissemination Areas (DAs) were retrieved using the package `cancensus` (von Bergmann et al., 2021). Dissemination Areas are the smallest publicly available census geography in Canada. We use data from the 2016 Population Census.

Origins: Residential parcels

We converted all recorded residential parcels in the City of Hamilton to points on the road network. Each point includes information about the number of residential units in the parcel. Each residential unit is "populated" with the probability of being a "low income household," which we define as having a total household income of less than CAD 40,000. This is approximately the mid-point of the low income cut-off (LICOs) for families in Canadian cities with populations greater than 500,000 in 2016, to match other Census data (Statistics Canada, 2020b).

Destinations: Foodbanks

The locations of foodbanks were obtained from public records and geocoded. Three urban sites not in the program were also identified and geocoded for comparison purposes.

Routing and travel time tables

Travel time tables for three modes (car, transit, walking) were computed using the parcels as the origins and the locations of the foodbanks as the destinations. For routing, the package `r5r` (Pereira et al., 2021b) was used, with a network extract for the City of Hamilton from OpenStreetMaps and the General Transit Feed Specification from Hamilton Street Railway, the local transit operator. For routing purposes we used maximum values of 180 min and 10,000 m walking distance: any destination that exceeded these thresholds was ignored. The departure time used for routing was **TIME**.

Open Hamilton ???

We used the open data portal of the City of Hamilton[5] we obtained boundaries for the city's various regions (the definition of urban, suburban, and rural regions follows the classification of development applications).

[4]add repository

[5]https://open.hamilton.ca/

Table 1: Accessibility by age group among members of low income households.

Population			Accessibility		
Children (age $\leq$ 18)	Adults (19-64)	Seniors (age $\geq$ 65)	Before COVID-19	During COVID-19	Difference
7,015	21,586	9,158	0.00734	0.00438	-0.00296
3,490	13,598	6,618	0.01386	0.00812	-0.00575
966	5,180	4,310	0.01475	0.00849	-0.00625
2,384	7,725	5,595	0.01853	0.01079	-0.00775

Note:
Population values have been rounded

Transportation Tomorrow Survey

We used the Data Retrieval System of the Transportation Tomorrow Survey (TTS)[6] to download cross-tabulations of: 1) primary mode of travel per trip by income by place of residence; and 2) age by income by place of residence. These data are from the 2016 Survey (the most recent available), and data are geocoded at the level of Traffic Analysis Zones (TAZ) using the most recent zoning system from 2006. Each parcel point is populated with the proportion of trips by three modes of travel: car (as driver or passenger), transit, and walk.

Expected Travel Times

Once we obtained travel time tables with population (number of households) and proportion of trips by mode, we calculated the expected travel time *ett* from each parcel i to a foodbank j as follows:

$$ett_i = p_i^c \cdot tt_{ij}^c + p_i^t \cdot tt_{ij}^t + p_i^w \cdot tt_{ij}^w$$

where p_i^k is the proportion of trips by mode k in the TAZ of parcel i, and tt_{ij}^k is the travel time from parcel i to the foodbank. In other words, the expected travel time is the weighted sum of travel times to the foodbank, with the weights given by the expected modal split in the TAZ.

Results and Discussion

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Conclusions

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[6] http://dmg.utoronto.ca/

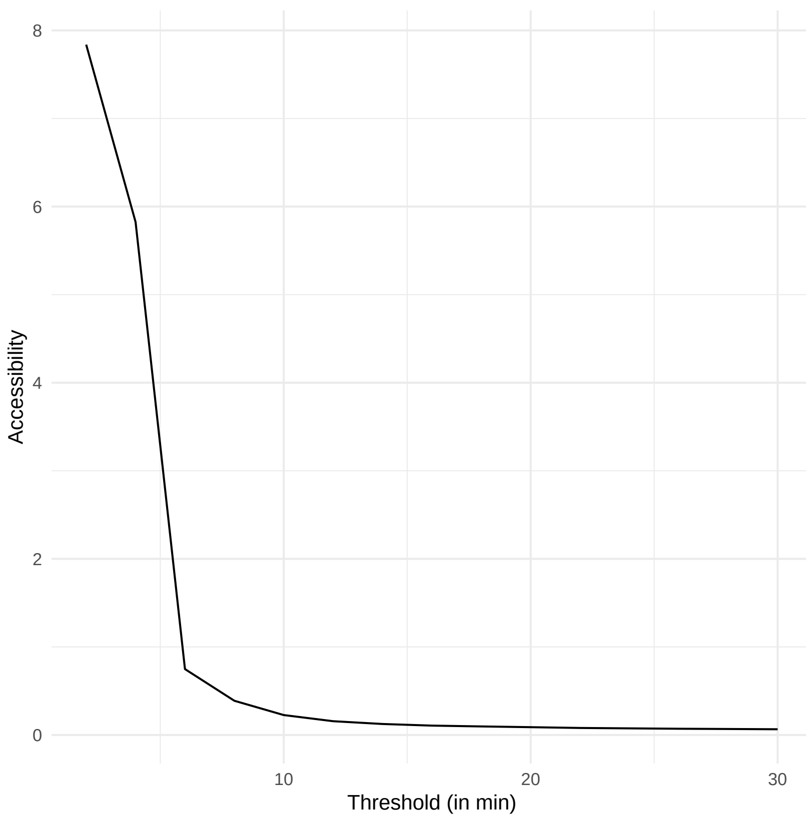

Figure 1: Accessibility as a function of threshold

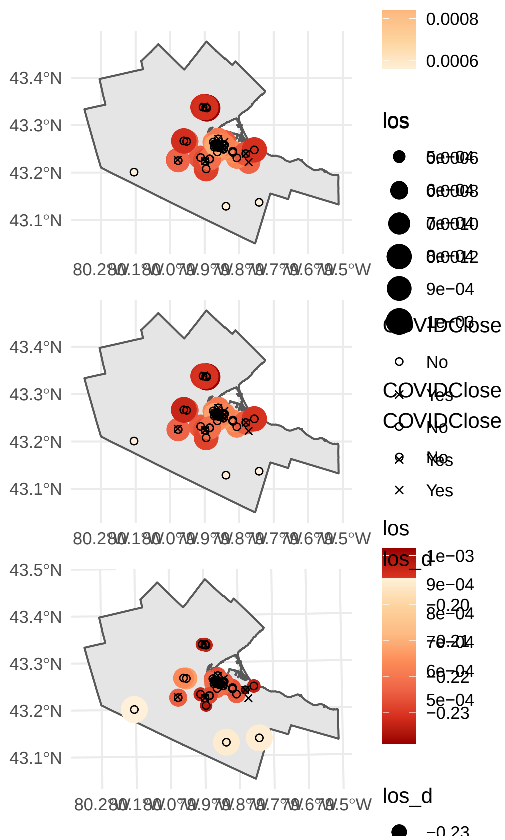

Figure 2: Levels of service at each facility pre-COVID-19 (top panel) and during COVID-19 (middle panel). The bottom panel shows the change in level of service.

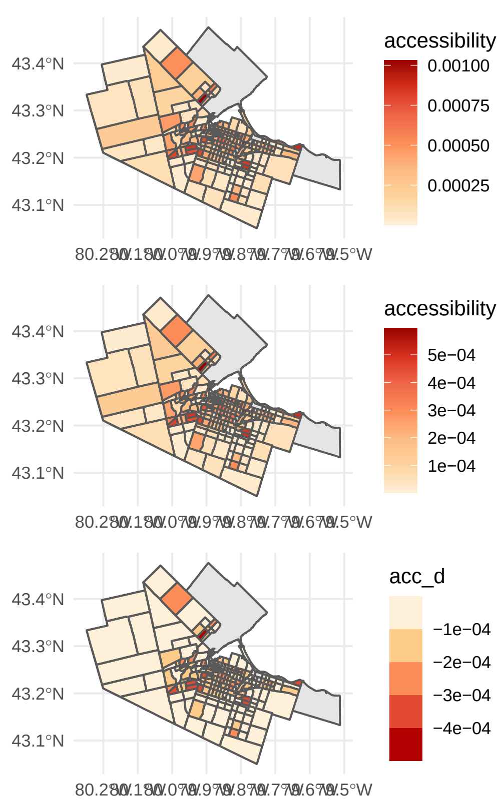

Figure 3: Accessibility by traffic analysis zone pre-COVID-19 (top panel) and during COVID-19 (middle panel). The bottom panel shows the change in accessibility.

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